(12) UK Patent Application (19) GB (11) 2 365 955 (13) A

(43) Date of A Publication 27.02.2002

(21) Application No 9819494.7

(22) Date of Filing 09.09.1998

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(51) INT CL^7
F25B 39/04

(52) UK CL (Edition T)
F4H HGXB HG2L HG2N HG2S H2D

(56) Documents Cited
GB 2318180 A EP 0961092 A1
WO 86/00393 A1

(58) Field of Search
UK CL (Edition S) F4H HGXB HG17 H2D
INT CL^7 F25B 39/04 , F28D 5/02
ONLINE DATABASES: WPI EPODOC JAPIO

(54) Abstract Title
Evaporative condensing apparatus

(57) An evaporative condensing apparatus is used in an air conditioner to reduce its power consumption. The evaporative condensing apparatus is based on the rule that the condensing temperature is directly proportional to the condensing pressure during the exchange of a cooling agent between liquid state and gas state. The evaporative condensing apparatus includes an evaporative condensing unit (20) having a plurality of condenser coils and absorptive means covering the condensor coils. A low compression ratio compressor (10) pumps a gas cooling agent into the evaporative condensing unit. A water supply system (40) includes an electromagnetic valve to let cooling water be delivered from a water source to the layer of absorptive material of each condenser coil. A condenser fan (60) is controlled to draw currents of air through gaps in the condenser coils of the evaporative condensing unit to carry heat away from the evaporative condensing unit (20).

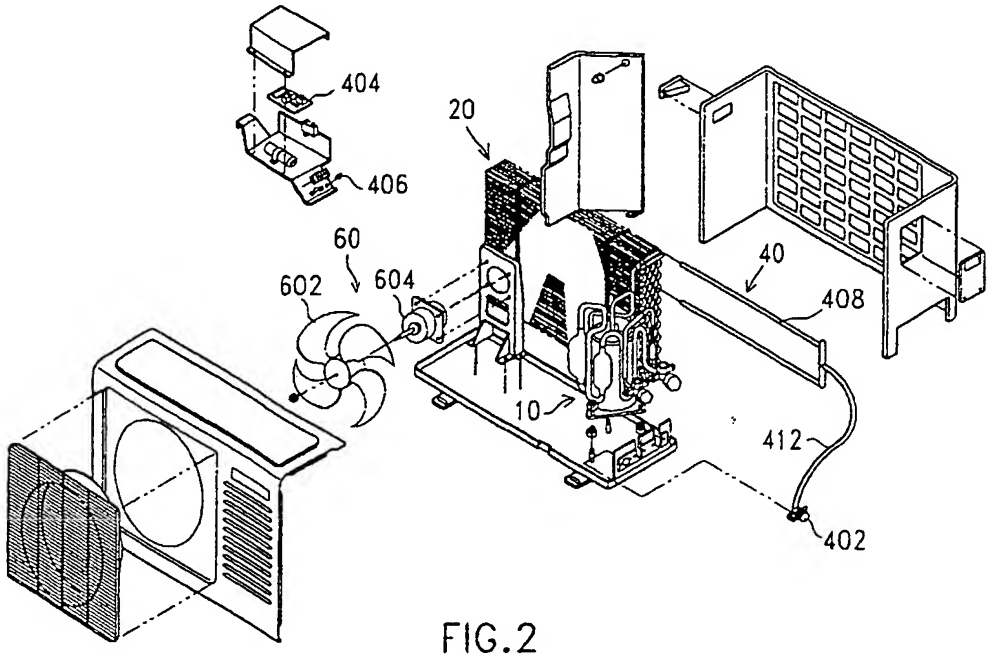

FIG.2

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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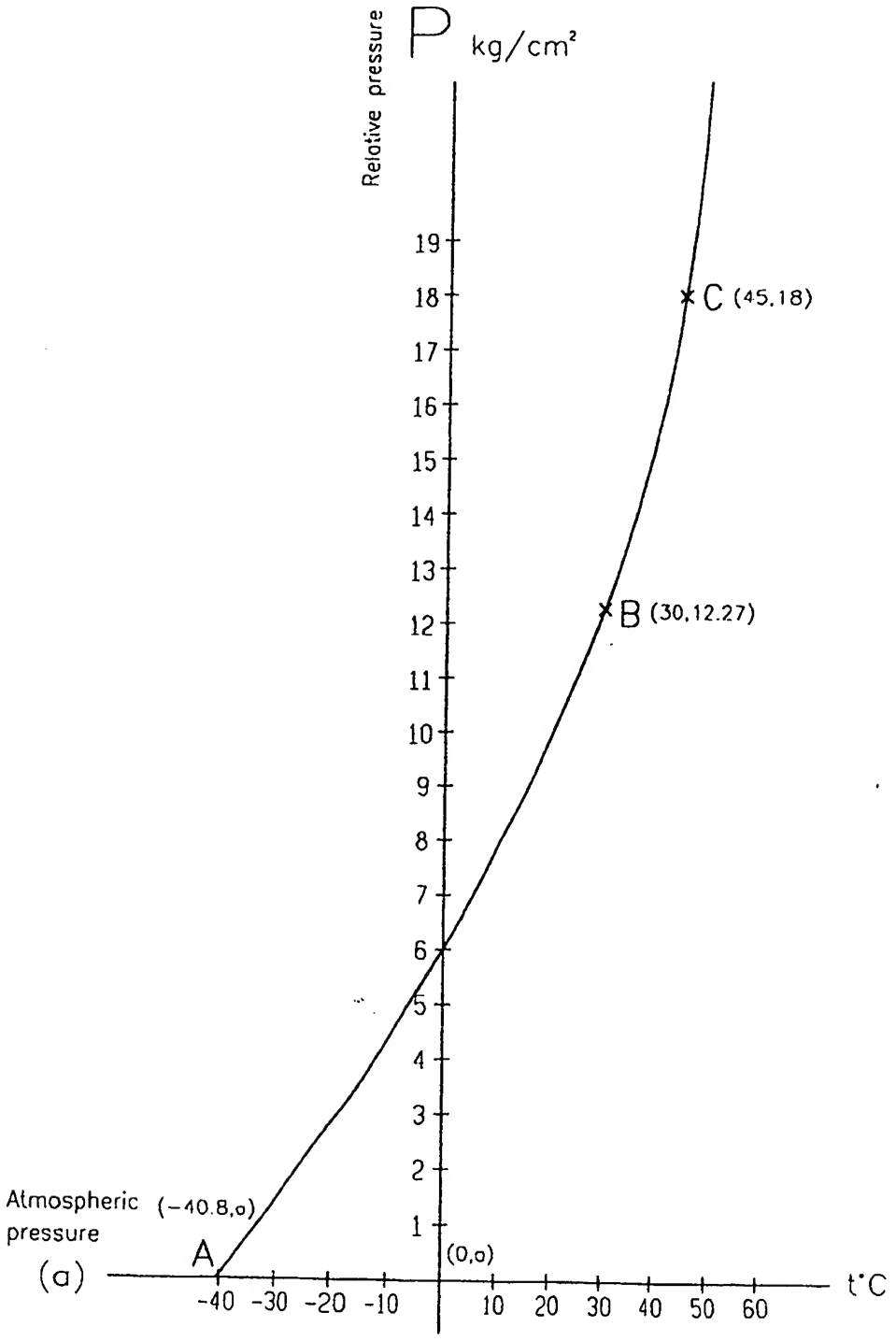
Relative pressure
P kg/cm²
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
C (45.18)
B (30,12.27)
A
Atmospheric pressure
(a)
(−40.8,o)
(0,o)
-40 -30 -20 -10
10 20 30 40 50 60
t°C

FIG.1

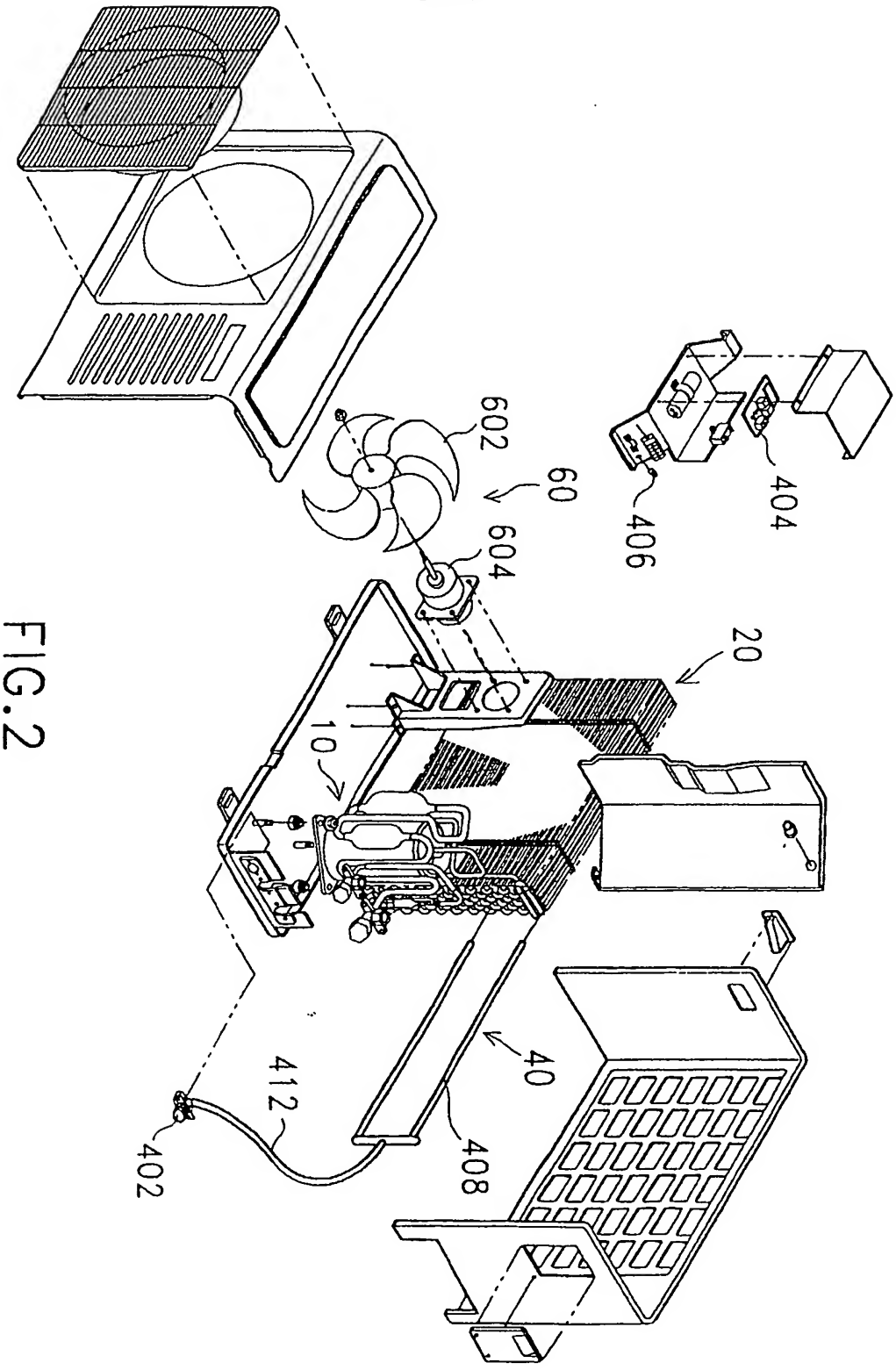

FIG.2

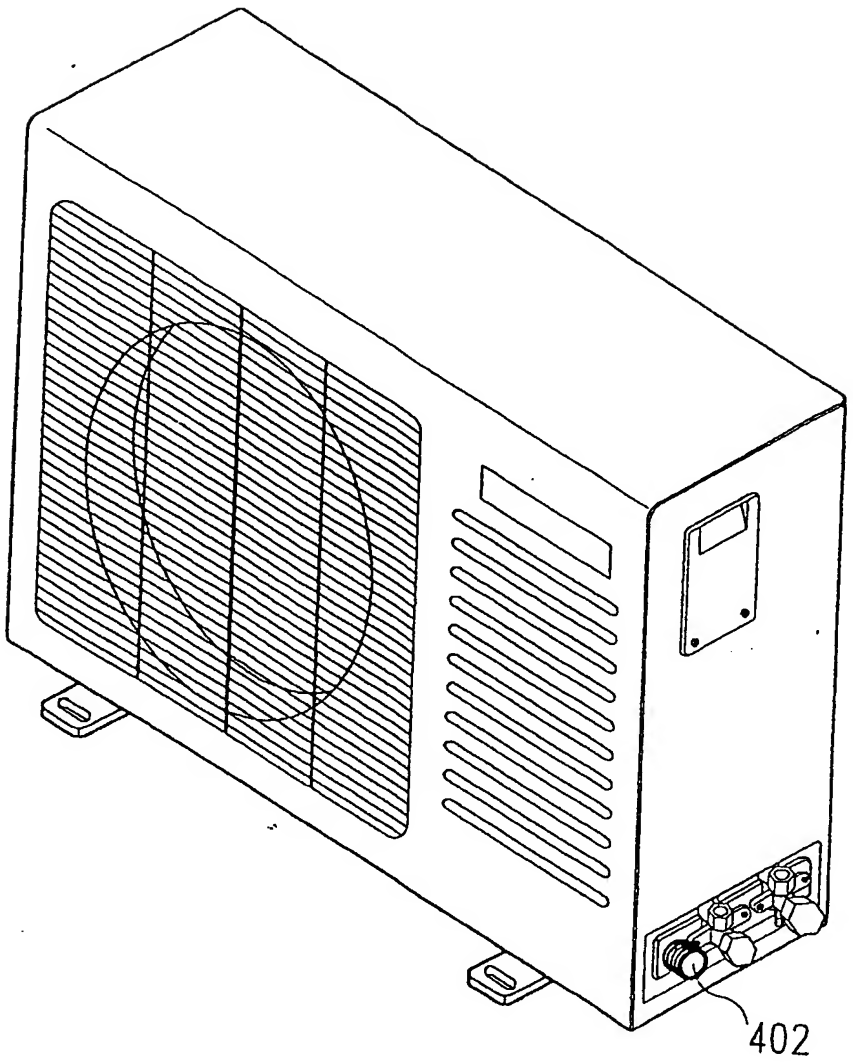

FIG.3

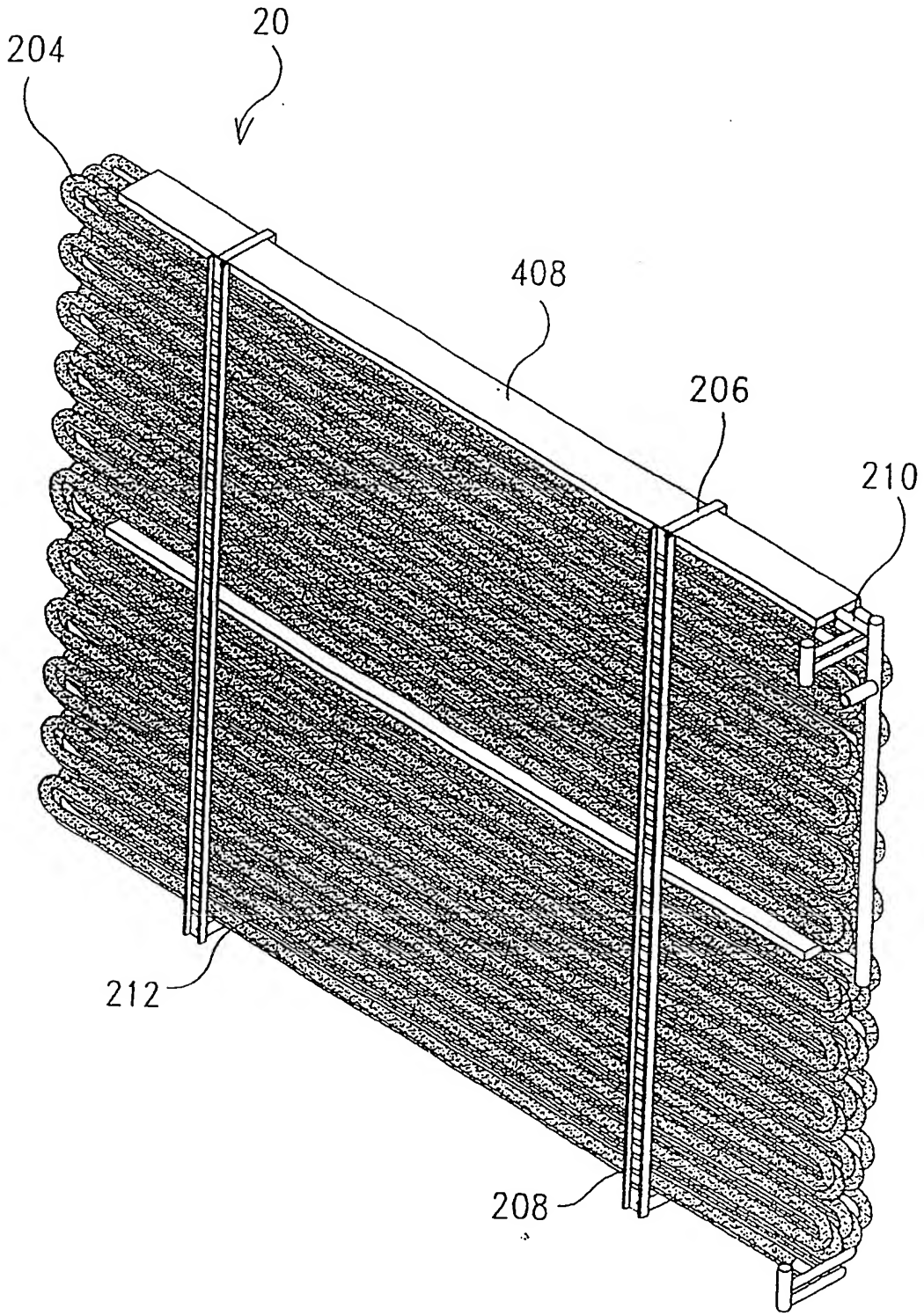

FIG.4

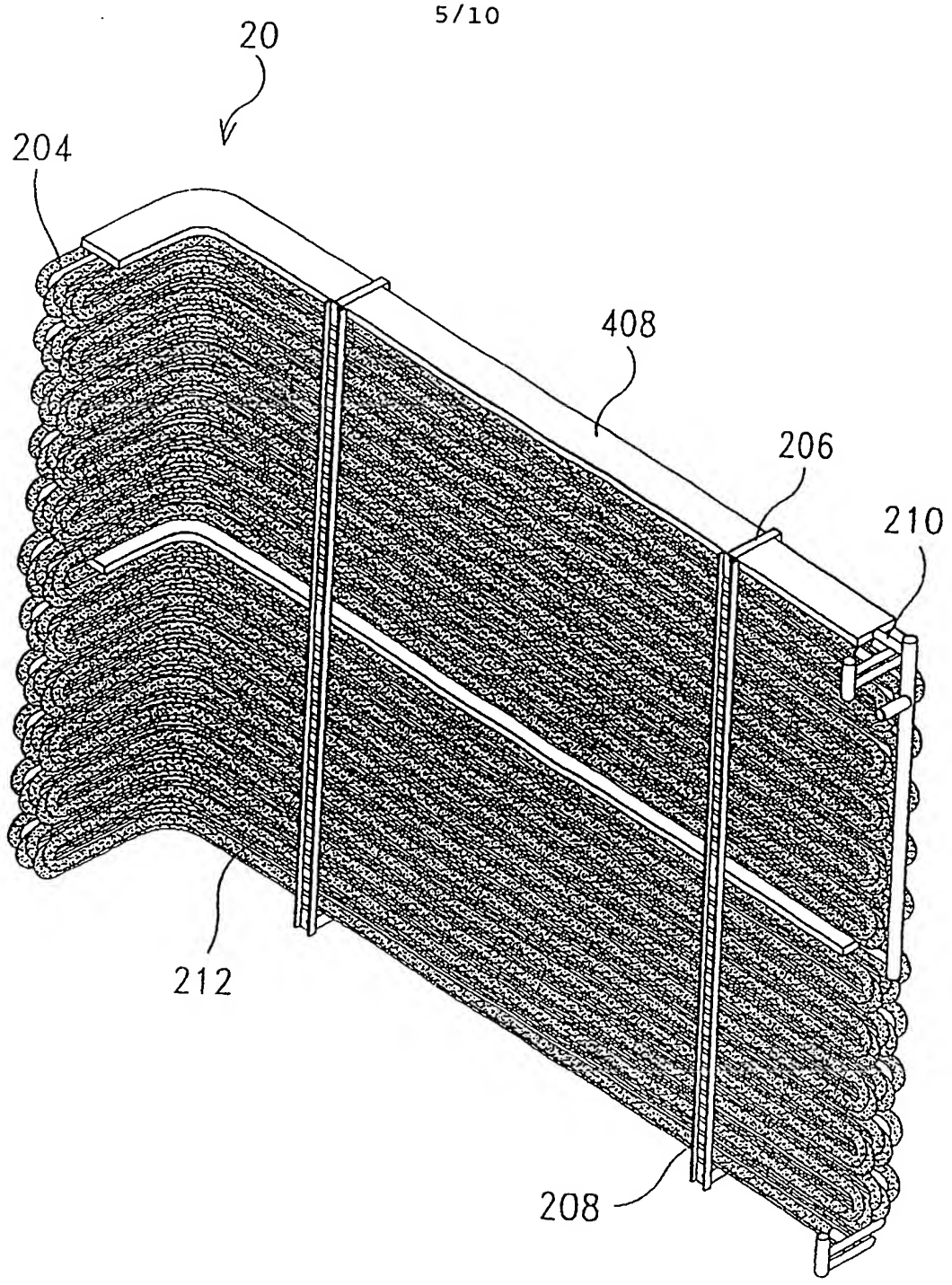

FIG.5

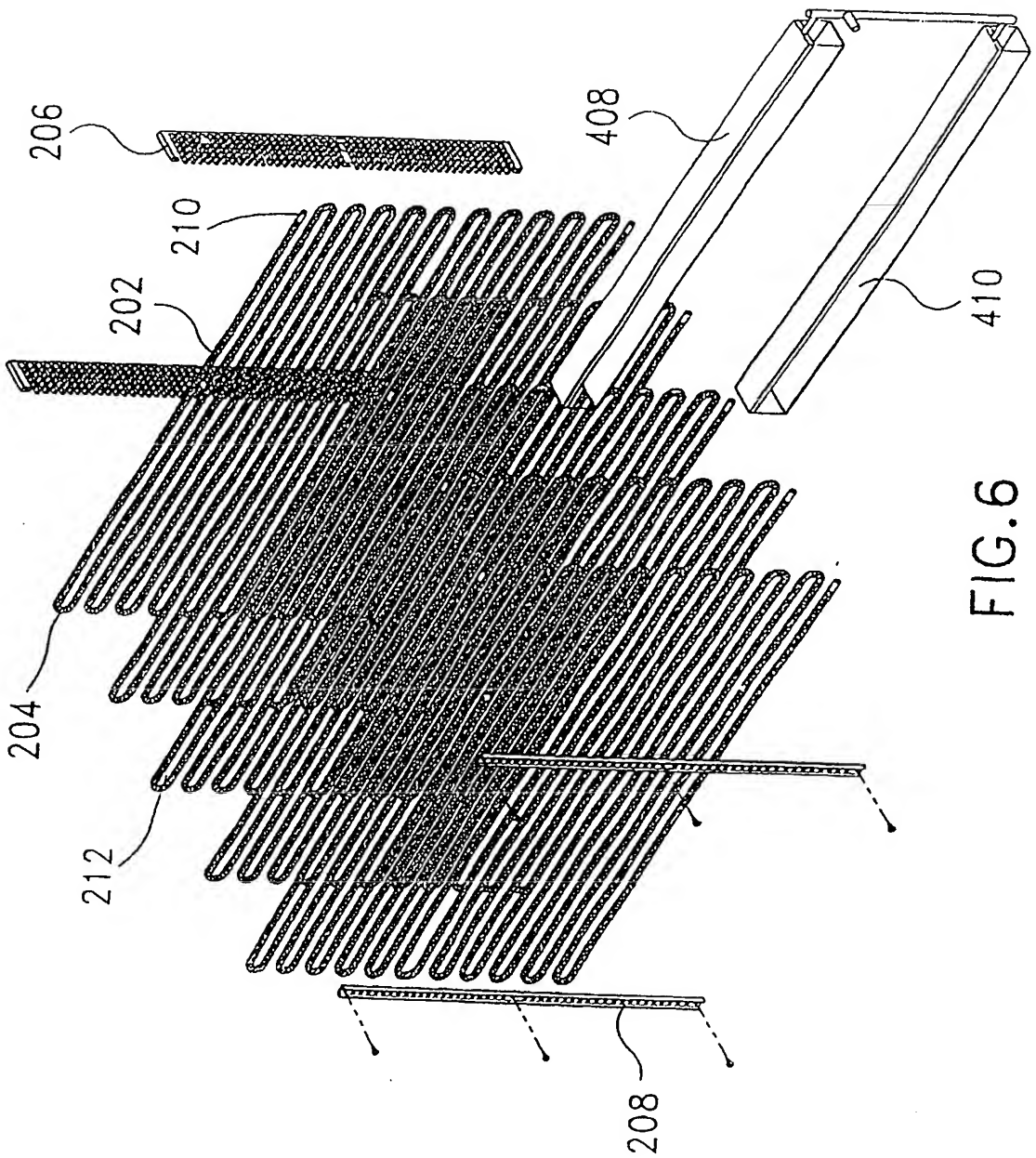

FIG.6

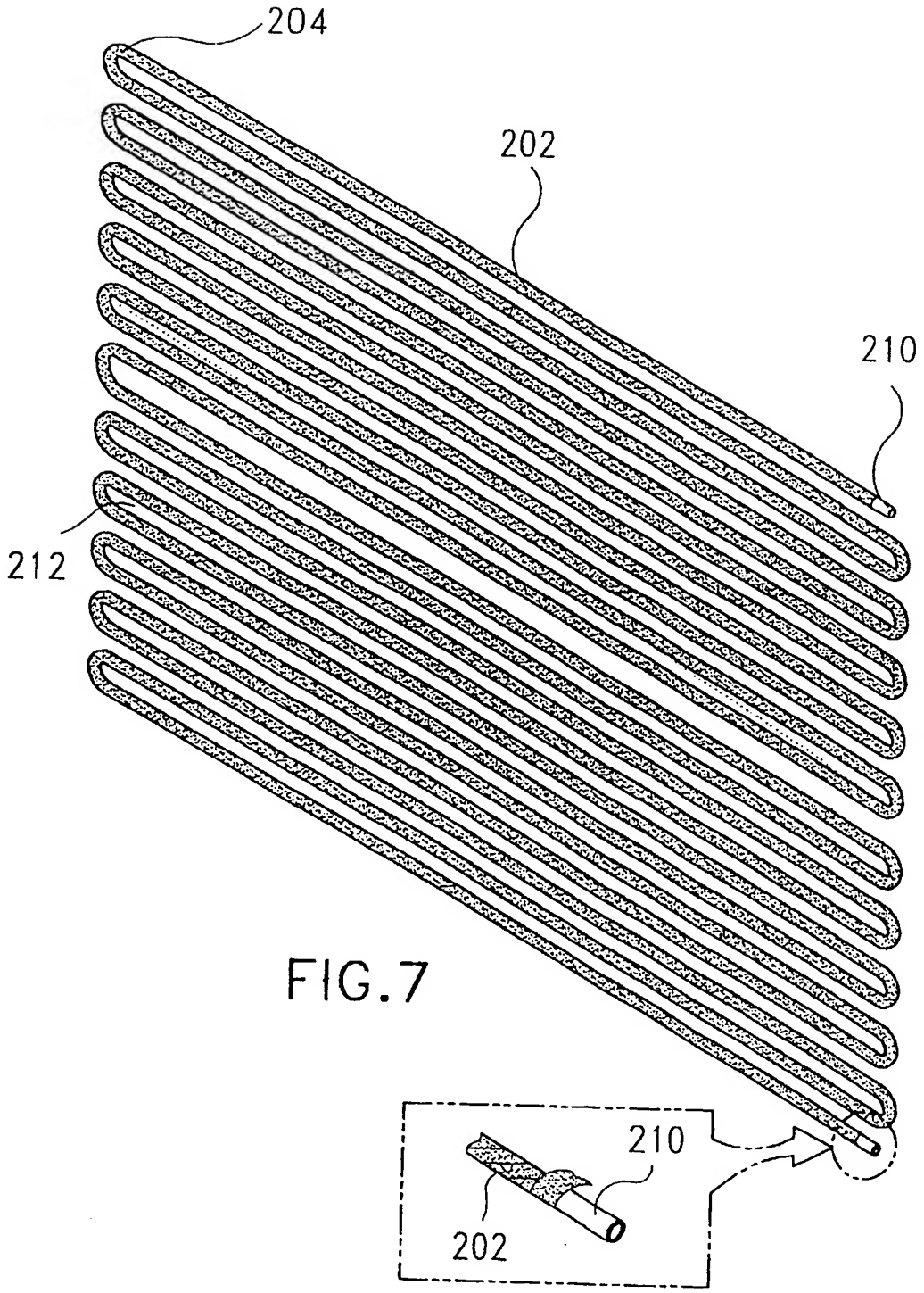

FIG.7

FIG.7A

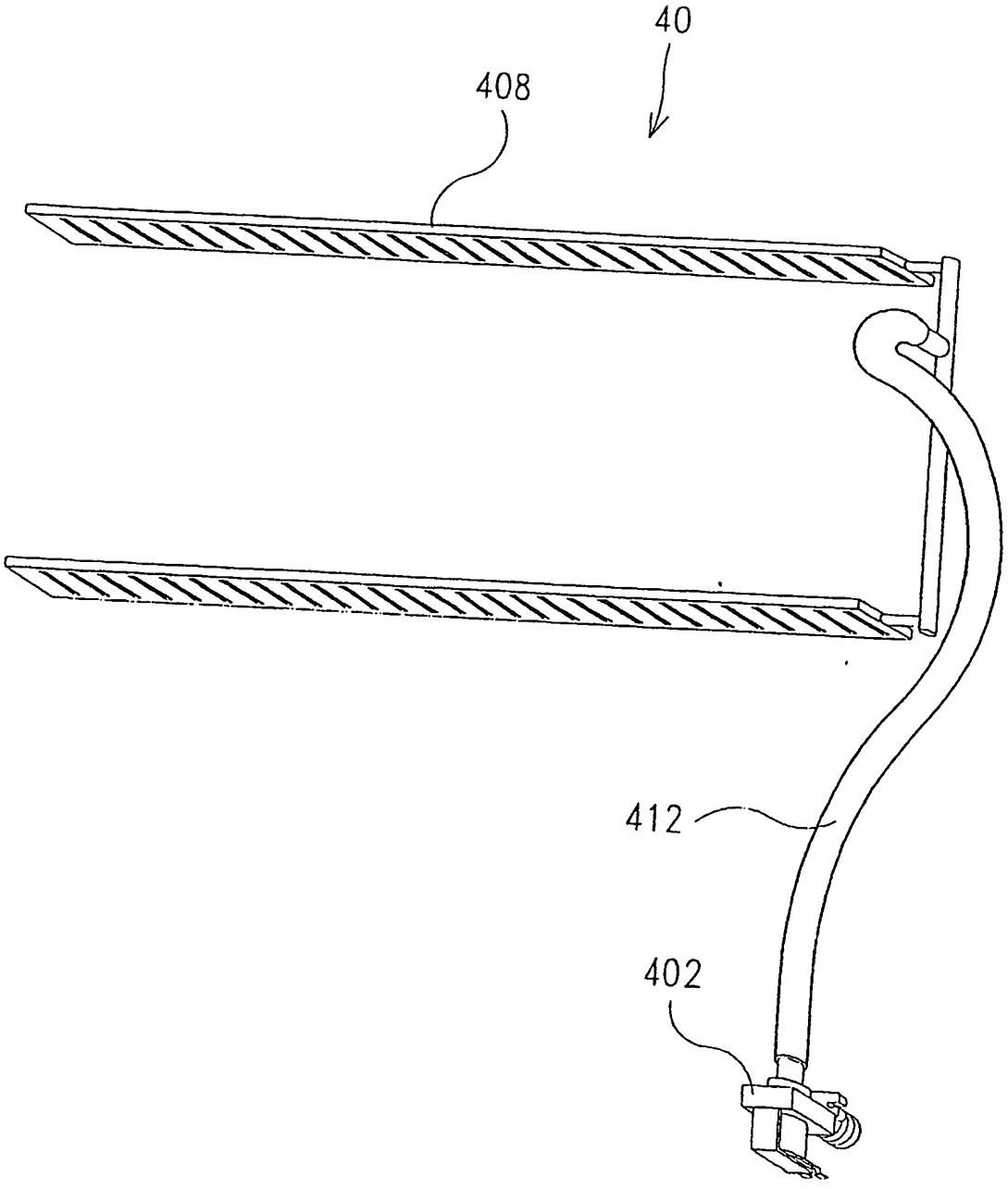

FIG.8

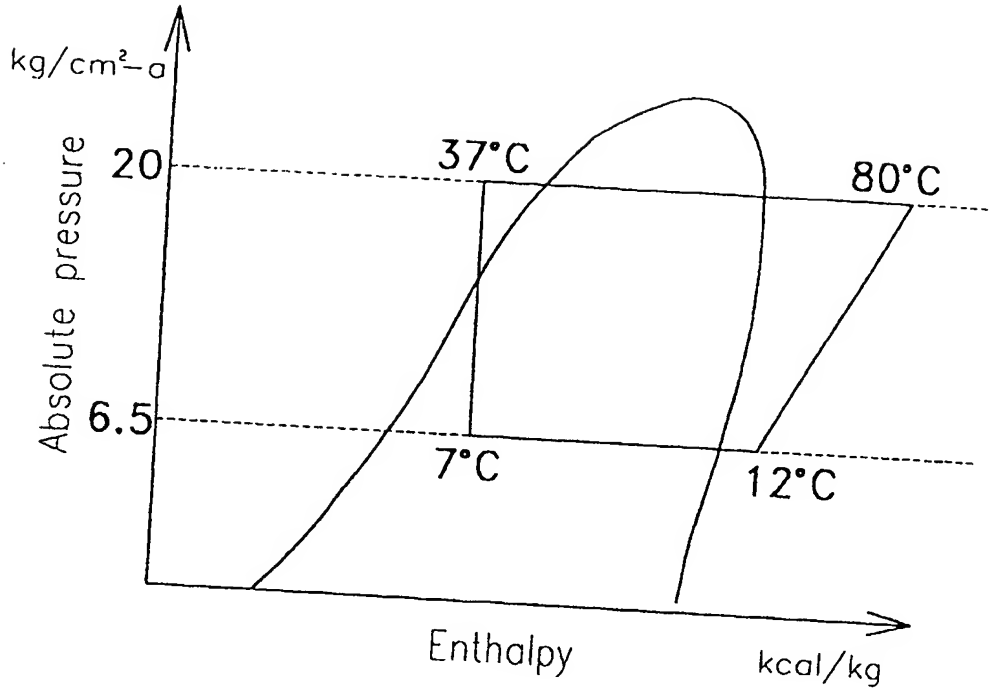
kg/cm²-a
Absolute pressure
20
6.5
37°C
80°C
7°C
12°C
Enthalpy
kcal/kg

FIG.9

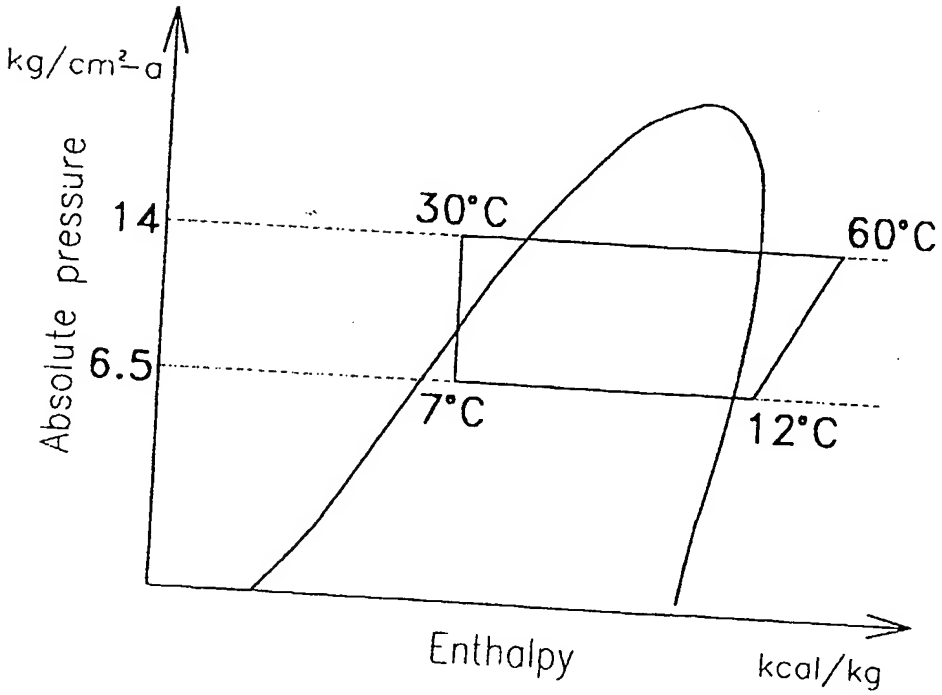
kg/cm²-a
Absolute pressure
14
6.5
30°C
60°C
7°C
12°C
Enthalpy
kcal/kg

FIG.10

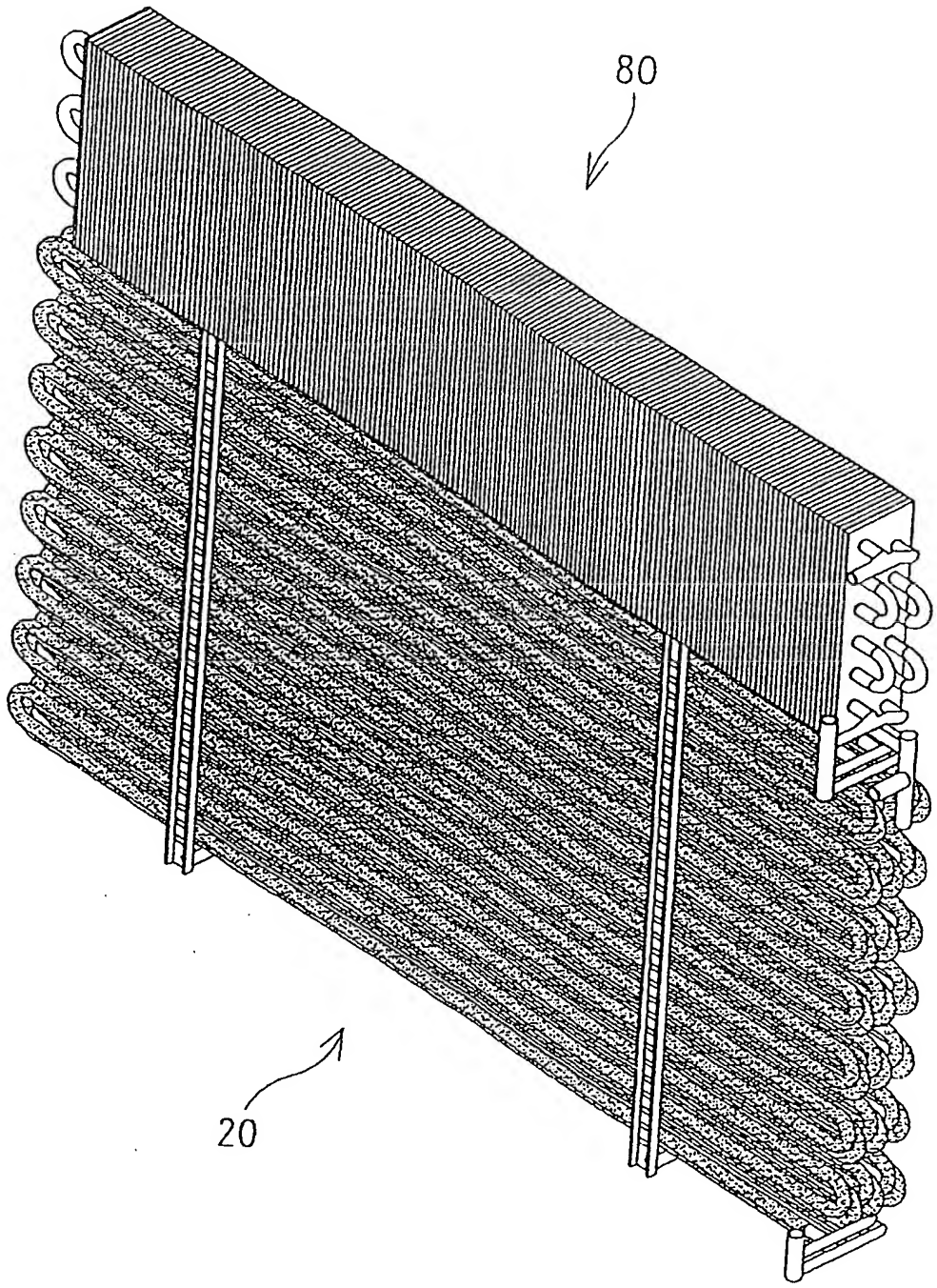

FIG.11

EVAPORATIVE CONDENSING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to an evaporative condensing apparatus for use in an air conditioner (cooler), and more particularly to such an evaporative condensing apparatus which greatly improve the working efficiency of the air conditioner (cooler).

Air conditioners (coolers) are intensively used in most countries in summer for air-conditioning buildings, rooms, trains, cars, etc. When an air conditioner is operated, it consumes much energy. In a regular air conditioner, a liquid state cooling agent is guided to an evaporator to make a heat exchange with air, permitting cooling air to be guided into the inside space of a building, room, train or car. After a heat exchange process, the liquid state cooling agent is changed into a gas state cooling agent, the gas state cooling agent is then compressed by a compressor and pumped to a condenser where the gas state cooling agent is returned to the liquid state again. Further, the condensing units of conventional air conditioners include three types, namely, the air cooling type, the water cooling type and the evaporative type. An air cooling type air conditioner uses convention currents of air to carry heat away from its condensing unit. In order to let heat be quickly carried away, much air contact surface and high currents of

air are needed. Therefore, an air cooling type air conditioner is heavy, consumes much energy, and produces high noise during its operation. A water cooling type air conditioner uses cooling water to carry heat away from its condensing unit. However, a water cooling type air conditioner is expensive, and consumes much cooling water. Further, the installation of a water tower for a water cooling type air conditioner is complicated, and may cause an American veteran syndrome. An evaporative type air conditioner dissipates heat by means of evaporation of water (one liter of water absorbs about 539 cal. when evaporated). The heat dissipation effect of an evaporative type air conditioner is much better than an air cooling type air conditioner and a water cooling type air conditioner. However, when an evaporative type air conditioner is used, water storage means is needed to collect waste water that is not evaporated at the evaporative condensing unit of the air conditioner.

SUMMARY OF THE INVENTION

The present invention has been accomplished to provide an evaporative condensing apparatus for an air conditioner which eliminates the aforesaid drawbacks. It is one object of the present invention to provide an evaporative condensing apparatus which enables supplied cooling water to be fully evaporated so that heat can be efficiently carried away during its operation. It is another

object of the present invention to provide an evaporative condensing apparatus which is compact, has all in it, and can conveniently be installed in an air conditioner. According to one aspect of the present invention, the evaporative condensing apparatus comprises an evaporative condensing unit for condensing a gas state cooling agent into a liquid state, the evaporative condensing unit having a plurality of condenser coils and absorptive means covered on the condenser coils, a low compression ratio compressor controlled to pump a gas state cooling agent into the evaporative condensing unit, a water supply system having a control PC board and an electromagnetic valve controlled by the control PC board to let cooling water be delivered from a water source to the layer of absorptive material of each condenser coil, and a condenser fan controlled to draw currents of air through gaps in the condenser coils of the evaporative condensing unit in carrying heat away from the evaporative condensing unit. According to another aspect of the present invention, the condenser coils each comprise a metal coil tube and a layer of absorptive material covered on the periphery of the metal coil tube, and the water supply system comprises a plurality of water spray tubes and absorptive material covered on the water outlets of the water spray tubes for permitting supplied cooling water to be evenly smoothly distributed to the absorptive material

at the condenser coils.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a liquid-gas curve obtained from R-22 cooling agent.

Figure 2 is an exploded view of an air conditioner constructed according to the present invention.

Figure 3 is an elevational view of the air conditioner shown in Figure 2.

Figure 4 is a perspective view of an evaporative condensing unit according to the present invention.

Figure 5 is a perspective view of an alternate form of the evaporative condensing unit according to the present invention.

Figure 6 is an exploded view of the evaporative condensing unit shown in Figure 4.

Figure 7 is a perspective view of a condenser coil according to the present invention.

Figure 7A is an enlarged view of a part of Figure 7.

Figure 8 is a schematic drawing showing the arrangement of the water spray tubes, water supply pipe and electromagnetic valve of the water supply system according to the present invention.

Figure 9 is a R-22 Mollier diagram obtained from a conventional condenser unit.

Figure 10 is a R-22 Mollier diagram obtained from an

evaporative condensing unit according to the present invention.

Figure 11 is a perspective view of a combination of condensing device according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 is liquid-gas curve obtained from R-22 cooling agent. As indicated, the cooling agent can easily be condensed with low condensing pressure when at a low temperature, for example: when at 45°C, the theoretical value of relative pressure is about 18kg/cm^2; if the temperature drops to 30°C, the theoretical value of relative pressure can drastically be reduced to 12.27kg/cm^2. Therefore, reducing the working pressure of the compressor of the condensing apparatus of an air conditioning or refrigerating system can greatly save the consuming power (horsepower), which drives the compressor, so as to improve the EER of the air conditioning or refrigerating system. The present invention is based on the rule that the condensing temperature is directly proportional to the condensing pressure during the exchange of a cooling agent between liquid state and gas state.

Referring to Figures 2 and 3, a low compression ratio compressor **10** is operated to pump a high pressure, high temperature, gas state cooling agent into an evaporative condensing unit **20**, permitting it to be condensed into liquid state. A water supply system **40** is controlled by a control PC board **404** to

periodically supply water to the evaporative condensing unit **20**. A condenser fan **60** which is comprised of a fan motor **604** and a fan blade unit **602** is controlled to causes currents of air through air passages in the evaporative condensing unit **20**, causing heat and moisture to be quickly carried away from the evaporative condensing unit **20**. The control PC board **404** comprises a water pressure selector switch for High, Medium, Low water pressure selections. The control PC board **404** controls an electromagnetic valve **402** of the water supply system **40**, causing the electromagnetic valve **402** to be closed/opened subject to the operation cycle of the compressor **10**, so that sufficient water can be supplied to the evaporative condensing unit **20** to cool down the cooling agent and the compressor **10**. During the operation of the compressor **10**, supplied water is evaporated with heat, and residual water, if any, is collected for a repeated use. The electromagnetic valve **402** controls the water passage between the water source, which can be for example water works, and the water supply pipe, referenced by **412**, of the water supply system **40**. The water supply system **40** further comprises a manual switch **406**, which is controlled to let water be continuously supplied for washing the machine, and a plurality of water spray tubes **408** respectively connected to the water supply pipe **412** and installed in the

evaporative condensing unit **20**.

Referring to Figures 4 and 5, the evaporative condensing unit **20** can have a straight shape as shown in Figure 4, or a curved shape as shown in Figure 5. The evaporative condensing unit **20** is comprised of a plurality of supporting frames **206**, a plurality of independent condenser coils **204** fastened to the supporting frames **206** and arranged in parallel or a staggered manner for circulation of a cooling agent, the condenser coils **204** being respectively covered with absorptive material **202** and defining a plurality of air gaps **212** between sections thereof, a plurality of packing frames **208** respectively fastened to the supporting frames **206** by screws to secure the condenser coils **204** and the supporting frames **206** together. Further, the water spray tubes **408** of the water supply system **40** (see also Figure 2) are respectively fastened to the supporting frames **206** at different elevations, and controlled to spray water over the condenser coils **204**. The water spray tubes **408** are respectively covered with absorptive material **410**, so that sprayed water can be absorbed by absorptive material **410** and then evenly smoothly distributed over the condenser coils **204**.

Referring to Figures 7 and 7A, the condenser coil **204** is comprised of a metal coil tube **210** and a tape of absorptive material **202** spirally wound round the metal coil tube **210**. Alternatively,

the absorptive material **202** can be made in the form of a sleeve and sleeved onto the condenser coil **204**. The absorptive material **202** can be obtained from non-woven cloth, cloth, natural fibers, synthetic fibers, reclaimed fibers, inorganic fibers, etc.

Referring to Figure 8, the water spray tubes **408** can be round tubes or flat tubes. The water outlets of the water spray tubes **408** can be designed having a narrow elongated shape, or a circular shape. Each water spray tube **408** has a diameter gradually reducing from the water supply pipe **412** toward the end, so that cooling water can evenly be distributed to the evaporative condensing unit **20**.

As indicated above, the evaporative condensing unit **20** is comprised of a plurality of condenser coils **204**, each condenser coil **204** comprising a metal coil tubes **210** covered with a layer of absorptive material **202**. When cooling water is delivered out of the water spray tubes **408** of the water supply system **40**, it is absorbed by the absorptive material **202** of the condenser coil **204** for heat exchange with the cooling agent passing through the metal coil tubes **210** of the condenser coils **204**, permitting heat to be quickly carried away by currents of air passing through the air gaps **212** in the evaporative condensing unit **20**. Because the electromagnetic valve **402** of the water supply system **40** is

controlled by the control PC board **404**, the amount of cooling water supplied from the water supply system **40** to the evaporative condensing unit **20** can be controlled approximately equal to the amount of water being evaporated during the operation of the machine.

Figure 9 illustrates a R-22 Mollier diagram obtained from a conventional condenser unit. Figure 10 illustrates a R-22 Mollier diagram obtained from an evaporative condensing apparatus according to the present invention. In Figure 9, the temperature of the gas state cooling agent at the input port of the condenser unit is about 80°C, the temperature of the liquid state cooling agent at the output port of the condenser unit is about 37°C, and the condensing pressure is about 20kg/cm^2-a. In Figure 10, the temperature of the gas state cooling agent at the input port of the evaporative condensing apparatus is about 60°C, the temperature of the liquid state cooling agent at the output port of the evaporative condensing apparatus is about 30°C, and the condensing pressure is about 14kg/cm^2-a (theoretically the condensing pressure if R-22 at 30°C is about 12.27 kg/cm^2-a, see Figure 1). Because the compression ratio is greatly reduced, the temperature of the condensed cooling agent can be reduced by about 7°C, therefore the efficiency is improved by about 20%. Because the compression ratio is greatly reduced, the consuming power of the compressor **10** can be reduced

by about 25% in comparison with an equivalent conventional unit. Therefore, the evaporative condensing apparatus of the present invention can greatly reduce the power consumption of an air conditioner or refrigerator, and greatly improve its EER (or COP) value by about 50%. According to tests made on model RC870489, which is obtained from Shuan-Shih Electric Engineers Taiwan, at Air-conditioner Department of Hsu-lin Laboratory of Taiwan Power Research and Test Center, the EER value is as high as 4.027kca/h.W (COP 4.68). In comparison with equivalent conventional devices, it saves power consumption by about 40%.

Referring to Figure 11, the evaporative condensing unit **20** can be attached to a regular air cooling condenser **80** to form a combination of condensing device.

It is to be understood that the drawings are designed for purposes of illustration only, and are not intended as a definition of the limits and scope of the invention disclosed.

What the inventi n claimed is:

1. An evaporative condensing apparatus comprising:

an evaporative condensing unit for condensing a gas state cooling agent into a liquid state, said evaporative condensing unit comprising a plurality of condenser coils having absorptive means covered thereon;

a low compression ratio compressor controlled to pump a gas state cooling agent into said evaporative condensing unit;

a water supply system having a control PC board and an electromagnetic valve controlled by said control PC board to let cooling water be delivered from a water source to the layer of absorptive material of each of said condenser coils of said evaporative condensing unit; and

a condenser fan having a fan motor and a fan blade unit driven by said fan motor to draw currents of air through gaps in the condenser coils of said evaporative condensing unit in carrying heat away from said evaporative condensing unit.

2. The evaporative condensing apparatus of claim 1 wherein said control PC board of said water supply system comprises a selector switch for high, medium and low water pressure selections, and controls the operation of said electromagnetic valve subject to the operation cycle of said low compression ratio compressor, permitting cooling water to be

periodically supplied to said evaporative condensing unit in such a manner that the evaporating rate of water at said evaporative condensing unit is approximately equal to the supply volume of cooling water from said water supply system.

3. The evaporative condensing apparatus of claim 1 wherein said water supply system comprises a water supply pipe having a water input end connected to said electromagnetic valve and a water output end, and plurality of water spray tubes respectively connected to the water output ends of said water supply pipe for guiding cooling water to said condenser coils, said water spray tubes each having a diameter gradually reduced from said water supply pipe, a plurality of water outlets respectively facing said condenser tubes, and an absorptive material provided at said water outlets.

4. The evaporative condensing apparatus of claim 1 wherein said water supply system further comprises a manual switch controlled to let water be continuously supplied to said evaporative condensing unit.

5. The evaporative condensing apparatus of claim 1 wherein said evaporative condensing unit comprises at least one supporting frame, which supports said condenser coils, and at least one packing frame fastened to said supporting frame to hold said condenser coils in place.

6. The evaporative condensing apparatus of claim 5 further comprising an air cooling radiating fin type condensing unit attached to said evaporative condensing unit.

7. The evaporative condensing apparatus of claim 5 wherein said condenser coils each comprise a metal coil tube and a layer of absorptive material covered on the periphery of said metal coil tube.

8. Evaporative condensing apparatus as claimed in claim 1 and as herein described.

9. Evaporative condensing apparatus as herein described and illustrated in the accompanying drawings.

The Patent Office

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Application No:	GB 9819494.7	**Examiner:**	M C Monk
Claims searched:	All	**Date of search:**	7 December 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): F4H (HGXB, HG17, H2D)

Int Cl (Ed.7): F25B (39/04); F28D (5/02)

Other: ONLINE DATABASES: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2318180 A	NUTEC ELECTRICAL ENGINEERING CO LTD Consider whole document; see eg Fig.1; condenser (J2), water spray nozzles (18), condenser coated with porous hydroscopic material, fan (19), and compressor (M).	1,5,7 at least.
XE	EP 0961092 A1	HUAI-WEI WANG [Filing date 27.05.1998; designates GB] A water retaining layer is coated on the second condensing area (30); fan (40).	1 at least
A	WO 86/00393 A1	VISSER Example of similar heat exchanging apparatus with a standard condenser; water sprays (17).	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.